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Acoustical Assessment of Firing Range, Barksdale AFB, LA

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6. AUTHOR(S)

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Risk Analysis Division
2510 Fifth St.
Wright-Patterson AFB, OH 45433-7913

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AFRL-SA-WP-CL-2012-0058

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

An acoustical assessment was performed on Firing Range A at Barksdale AFB in January 2012. It was determined that the definition of impulse noise in AFOSH Standard 48-20 was not met due to acoustical reflections, particularly off the side walls. Therefore, it was recommended that acoustical absorption be added to these side walls.

15. SUBJECT TERMS

Impulse noise, impact noise, time delay, CATM, firing range, hearing, acoustics, noise, firearms

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					Mr. Andrew T. Wells
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DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

13 Jul 2012

MEMORANDUM FOR 2 AMDS/SGPB
ATTN: Lt Col Randy Smith
243 CURTISS RD
BARKSDALE AFB, LA 71110-2425

FROM: USAFSAM/OEHR
2510 FIFTH STREET
WRIGHT-PATTERSON AFB, OH 45433-7913

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2012-0058, Acoustical Assessment of Firing Range, Barksdale AFB, LA

1. INTRODUCTION:

a. *Purpose*: On 24-26 January 2012, the Risk Analysis Division of the United States Air Force School of Aerospace Medicine (USAFSAM/OEHR), at the request of 2 AMDS/SGPB, performed an acoustical assessment of the Combat Arms Training and Maintenance (CATM) firing range facilities at Barksdale AFB, LA.

b. *Survey Personnel*:

(1) TSgt Jerimiah Jackson
(2) Mr. Andrew T. Wells

c. *Personnel Contacted*:

(1) Lt Col Randolph Smith
(2) MSgt Eddie Bartlett
(3) TSgt Kevin Hillman
(4) SSgt Chad Bogacyzk
(5) SSgt Nicolas Niles
(6) SSgt Jorge Ortega
(7) SrA James Robinette

d. *Equipment*:

(1) B&K PULSE Analyzer, Type 3560-B-140, SN 2588445
(2) Larson Davis Microphone Power Supply, Model # 2221, SN 0207
(3) Larson Davis Preamplifier, Model # 902, SN 3824
(4) Larson Davis Microphone, Model # 2530, SN 1483
(5) Quest Calibrator, Model # QC-20, SN QF8050050

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2. BACKGROUND:

a. The Barksdale CATM Range A is a partially contained range with 21 firing stations used for M4 and M9 training (see Figure 1). A reverberant field occurs when firing as energy is reflected among the ceiling, walls, and floor surfaces, causing the noise to linger at high levels. These noise levels diminish slowly compared with free field conditions (i.e., outdoors, or indoors with acoustical absorption on the interior surfaces). Down-range of the firing line is a series of steel safety baffles on the ceiling that are designed to deflect stray bullets and prevent the bullets from leaving the range (see Figure 2). These panels are closely spaced and reflect acoustical energy, contributing to the lingering noise levels.

Figure 1. Down-range view of Barksdale CATM Range A

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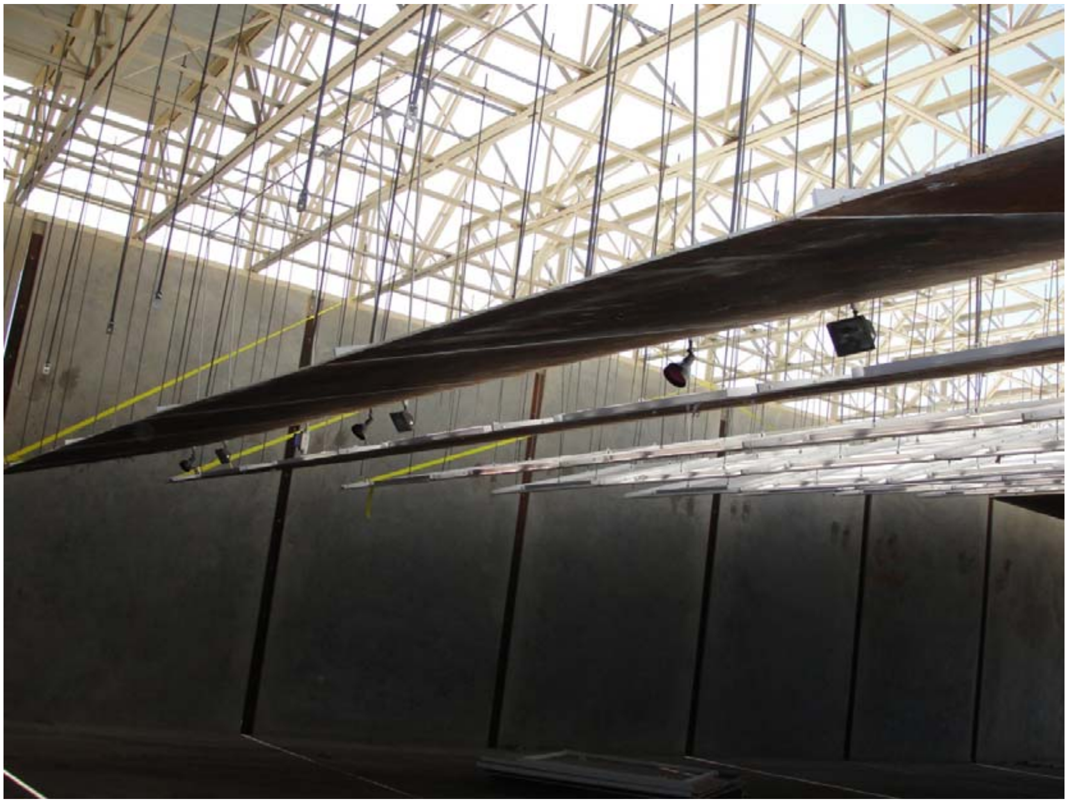

Figure 2. Side wall and overhead containment baffles

b. The range does not have a back wall behind the shooters as they face the bullet trap. The absence of a back wall creates a large opening through which acoustic energy can escape the range (see Figure 3). There is a control tower at the center of the opening that reflects acoustical energy back into the range.

c. The nonlinear acoustical effects of the gun fire peak noise, double hearing protection, and short-term residual auditory effects from gunfire make it very difficult for students and instructors to communicate. Communication difficulties include understanding instructions and warning signals. To compensate for the multiple noise sources, the volume of the control tower speaker system is fixed at a high level. When hearing protection is not worn (i.e., providing/receiving group instruction), the students are exposed to high levels of noise from the speakers.

3. TEST PROCEDURE:

a. The sound pressure time histories corresponding to individual M4 shots were measured with ¼-inch microphones placed 5 feet above the yellow line (the safety line behind which students remain when not shooting). Time histories are measured sound pressure over duration of approximately 4 seconds. This duration provided sufficient time to completely describe the decay of the acoustical energy to background levels. These time histories were then used to compute acoustical decay characteristics.

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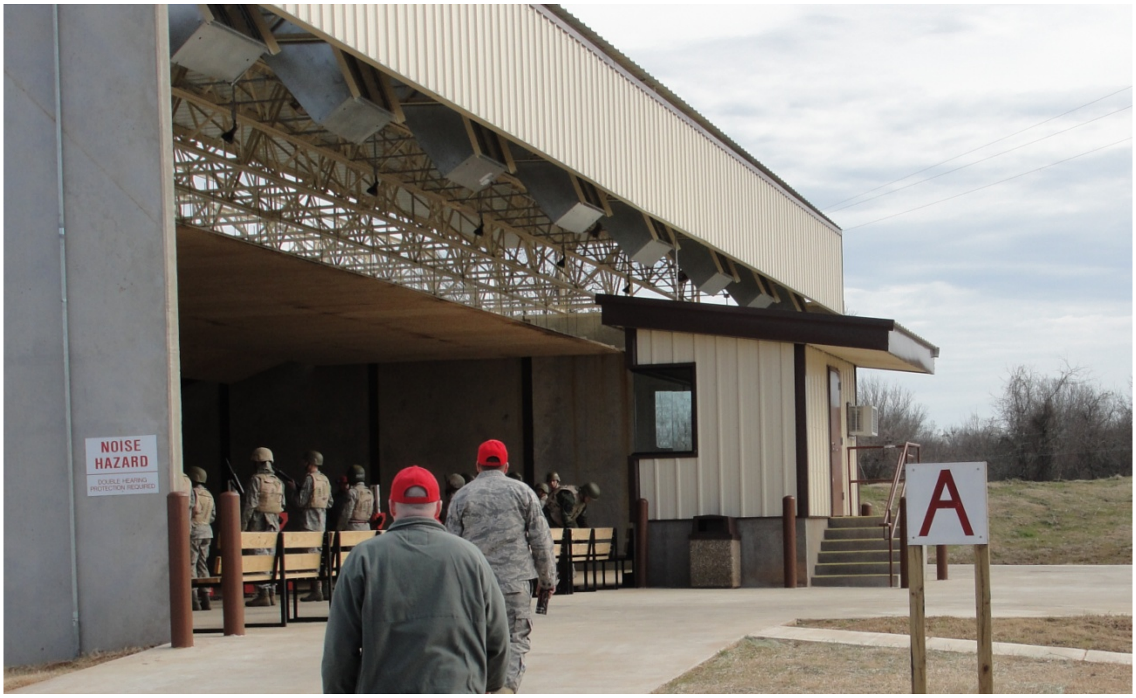

Figure 3. Open area behind shooters

b. The linear sound pressure level decay rates, in decibels per second, were computed by selecting the linear decay phase of each time history and performing a sound level versus time analysis through the decay phase. The slope of this curve is the decay rate.

c. Decay times, in seconds, were computed based on the decay rate by calculating the duration of time required for the sound pressure level to decay from the peak sound pressure level to a fixed level of 80 dB.

4. RESULTS:

a. The decay time, averaged over multiple shots at multiple shooter and microphone locations, was 2.6 seconds. See Table 1 for a summary of decay times for respective locations. In the observed configuration, the noise at this range does not meet the definition of impulse noise as defined in AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*:

> **Impulse or Impact Noise—**a short burst of acoustic energy consisting of either a single burst or a series of bursts. The pressure-time history of a single burst includes a rapid rise to a peak pressure followed by a somewhat lower decay of the pressure envelope to ambient pressure, both occurring within 1 second. A series of impulses may last longer than 1 second.

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Table 1. Mean Impulse Decay Time

Shooter Position	Mean Impulse Decay Time (s) for Microphone Position--				
	2	6	11	16	20
2	2.4	2.2	2.8	2.9	2.8
6	2.4	2.0	2.6	2.9	2.9
11	2.3	3.0	2.4	2.7	2.8
16	2.7	3.0	2.5	2.3	2.5
20	3.0	2.8	2.5	2.4	2.5

b. Hearing protection devices (HPDs) alone cannot adequately attenuate noise levels to protect students and instructors from hazardous noise exposure. The continuous noise levels in the range can exceed 150 dB at the shooter's ear. With noise level at 150 dB and assuming double hearing protection—using HPDs with a higher noise-reduction rating of 30+3 dB for dual protection (per AFOSH Standard 48-20) and de-rated by 50% (per OSHA)—the at-ear noise level would exceed 134 dBA.

5. CONCLUSIONS:

a. Speech intelligibility is poor due to the strong reverberant sound field of the range. This condition increases safety risks.

b. Based on an average decay time of 2.6 seconds, the noise in the range is not impulse noise; the noise is continuous noise. Thus, the hazardous noise does not meet the regulatory definition of impulse noise. Based on the continuous noise standard, there is no allowed exposure time above 115 dBA.

c. Because the range is open to the rear (opposite bullet traps) except for the tower, there is a great deal of acoustical absorption on this range. However, because this acoustical absorption is not distributed around the room surface, its effect is greatly diminished. Specifically, the side walls are parallel to each other and provide very little acoustical absorption, so they reflect sound back and forth across the range. Because of the orientation of the other surfaces and the timing of distinct pulses detected in many of the time histories, it is concluded that the side walls are the primary cause of the lengthy decay times on this range.

6. RECOMMENDATIONS:

a. Install sound absorbing material to reduce the reverberant field. The reverberant field in the range should be minimized to reduce the noise level to protect students and instructors from hazardous noise exposure and to improve speech intelligibility.

b. The side walls should be treated first, from about the back edge past the yellow and red lines to at least the far edge of the first overhead baffle. Treatment beyond this point will be helpful, but treatment applied closer to the bullet trap will have less impact on the occupied area. After the side walls are treated, treatment of the ceiling and the front of the tower can be considered if necessary.

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c. Due to the exposure to weather and contaminants, and concerns about rounds hitting mounting hardware, the selection of treatment material is particularly important. Ongoing research is being conducted by the USAFSAM/OEHR Noise Laboratory. Pyrok Acoustement 40 (NOT the Acoustement Plaster 40) appears to have potential, and Pinta Acoustic Willtec (would need a finish to keep out the elements) and Phonstop Ceiling and Wall Tile could be considered. We are happy to review the sound-attenuating properties of any locally procured materials you may wish to install, and will update you on the results of our own line of investigation.

d. The speaker system volume should be adjusted for weapon discharge or instructor lecturing. Additionally, CATM instructors provide just-in-time training to students on proper use of hearing protection devices as part of classroom instruction. NIOSH has a short video on proper insertion of foam ear plugs available for download at: http://www.cdc.gov/niosh/mining/products/movies/rphhi.wmv.

e. Until effective engineering controls can be implemented, close scrutiny to audiograms, as defined in Attachment 1 of AFOSH Standard 48-20, should be considered for CATM instructors.

f. Perform a follow-up assessment after acoustical treatment of the range is complete. The assessment would determine overall effectiveness and evaluate the type of noise—impulse noise versus continuous noise.

7. USAFSAM/OEHR will provide a follow-up letter of engineering control recommendations once a suitable wall treatment material can be found and recommended. If there are questions concerning the assessment, and for ongoing support, please contact Mr. Andrew Wells at DSN 798-3306 or via email at andrew.wells@wpafb.af.mil.

DAVID M. SONNTAG, Lt Col, USAF, BSC
Chief, Risk Analysis Division

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